Wet and Dry Deposition Vital Sign

Annual Report FY2009

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The ARCN Phase 3 Vital Signs Monitoring Plan lists five objectives for the Wet and Dry Deposition Vital Sign. In 2009, we made progress on each of these components as we develop this vital sign toward protocol writing in 2011. Objectives and progress are listed below.

1. **Establish baseline and long-term framework for monitoring concentrations of airborne Pb, Zn, Cd, Cu, Cr, Hg, Al, B, Fe, Ti, total S, total N, and NO_3^- using the moss *Hylocomium splendens* as a passive sampler.**

One of the key terrestrial protocols in this vital sign will be the network-wide sampling of contaminant deposition (total wet and dry) using *Hylocomium* tissue as a passive receptor. In order to add value to the deposition monitoring and modeling, most tissue collections will be co-located with Terrestrial Vegetation and Soils vital sign plots, enabling a linkage of chemistry and biotic effects. In 2009, we piloted field collection of *Hylocomium* at each Terrestrial Vegetation and Soils sampling transect. Samples were cleaned according to the protocols used by Hasselbach et al. (2005) and in subsequent projects (Neitlich et al. 2010, Neitlich and VerHoef 2011), and were submitted to the University of Minnesota Research Analytical Laboratories for elemental analysis. The 2007 collections of *Hylocomium* from lichen monitoring plots (another component of the Terrestrial Vegetation and Soils vital sign) were long-delayed due to contracting issues, but the data were finally received in March, 2010. We will begin to run QA checks on these data shortly. We are expecting delivery of the 2009 data in July 2010.

2. **Calibrate elemental concentrations in *Hylocomium splendens* with concentrations in passive air sampler devices (PASD) in order to be able to use moss concentrations to predict true deposition values on a landscape level.**

We have recently negotiated an Interagency Agreement (IA) with the USGS-Columbia Environmental Research Center to work on this model. Dr. Linda Geiser, Air Ecologist with USDA-Forest Service has also been secured as a co-PI in helping us develop this calibration model. Once completed, this calibration model will provide us with the ability to present moss elemental concentrations in units of atmospheric deposition compatible with air quality monitoring stations and critical loads calculations. We have many interested collaborators in Alaska (e.g., NPS-SWAN, USFWS, USDA-FS-FIA Program) who are also collecting *Hylocomium* statewide, and hope to use this model in developing a critical loads model for Alaska.

3. **Determine current levels of mercury in piscivorous freshwater fish (e.g., lake trout, sheefish) and relate these levels to age and lipid content of the individual fish.**

In late FY08, ARCN's former aquatic ecologist and WEAR's ecologist met with several of the PI's of the Western Airborne Contaminants Project (WACAP), and several lichen-air ecologists to discuss potential sampling objectives and designs for this vital sign. For aquatic systems, there was a consensus that we should proceed with decadal sampling of lake cores and a suite of fish and physical-chemical parameters for Hg and a targeted set of persistent organic pollutants (POP's). It was recommended that Hg sampling occur on a more regular basis, perhaps annually, with a more targeted set of fish receptors, and that we make provisions for opportunistic collaboration with other partners actively engaged in Hg sampling. These may include the Chief Veterinarian of the State of Alaska and a senior toxicologist with USFWS.

4. **Link *Hylocomium splendens* tissue sampling with surveys of lichen community structure currently conducted by Vegetation vital sign. This permits a linkage between observed pollutant levels and changes in community structure.**

Co-location of moss tissue sampling with lichen monitoring plots began in 2007, and continued with pilot vegetation monitoring in 2009. In FY2009, we continued to analyze the relationship between Zn levels and lichen community structure along the Red Dog Haul Road for a nearly completed journal manuscript (Neitlich et al. 2010). Of broader regional significance in the long term will be the develpment of a lichen-air gradient model linking northwest Alaska's potentially growing nitrogen or sulfur deposition with changes in lichen community structure.

5. **Monitor changes in deposition of Pb, Cd, and Zn along the Red Dog haul road in CAKR and link deposition levels with changes in sensitive nonvascular plant communities.**

In 2009, we continued to work towards completion on one manuscript documenting the effects of heavy metal pollution from the Red Dog Mine Haul Road on lichen community structure (Neitlich et al. 2010). Based on 2006 field sampling, this study documents the relationship of lichen decline with Zn deposition along the road, and maps the area of effect. A biological effects threshold based on elemental concentrations is proposed. After the lab analysis of FY2006 moss tissue arrived in late FY2008, we also undertook analysis of the remeasurement of the 2001 spatial patterns of contaminants study (Hasselbach et al. 2005). Spatial statistician Dr. Jay VerHoef ran a new set of conditional simulations (a Bayesian interpolation allowing for calculation of area above a threshold contaminant value) to model the spatial patterns of Zn, Pb and Cd distributions on a new prediction grid. Dr. VerHoef also modeled lichen species richness on this same grid for the lichen community structure study. Both studies are progressing toward release.

In 2009, we also undertook an intensification of earlier efforts suggesting that certain areas in Noatak National Preserve (NOAT) exceeded the effects threshold for effects on lichen communities. We sampled 39 new locations ranging from those immediately downwind and close to the Red Dog Mine to those with substantial wind shelter or greater distance (Fig. 1).

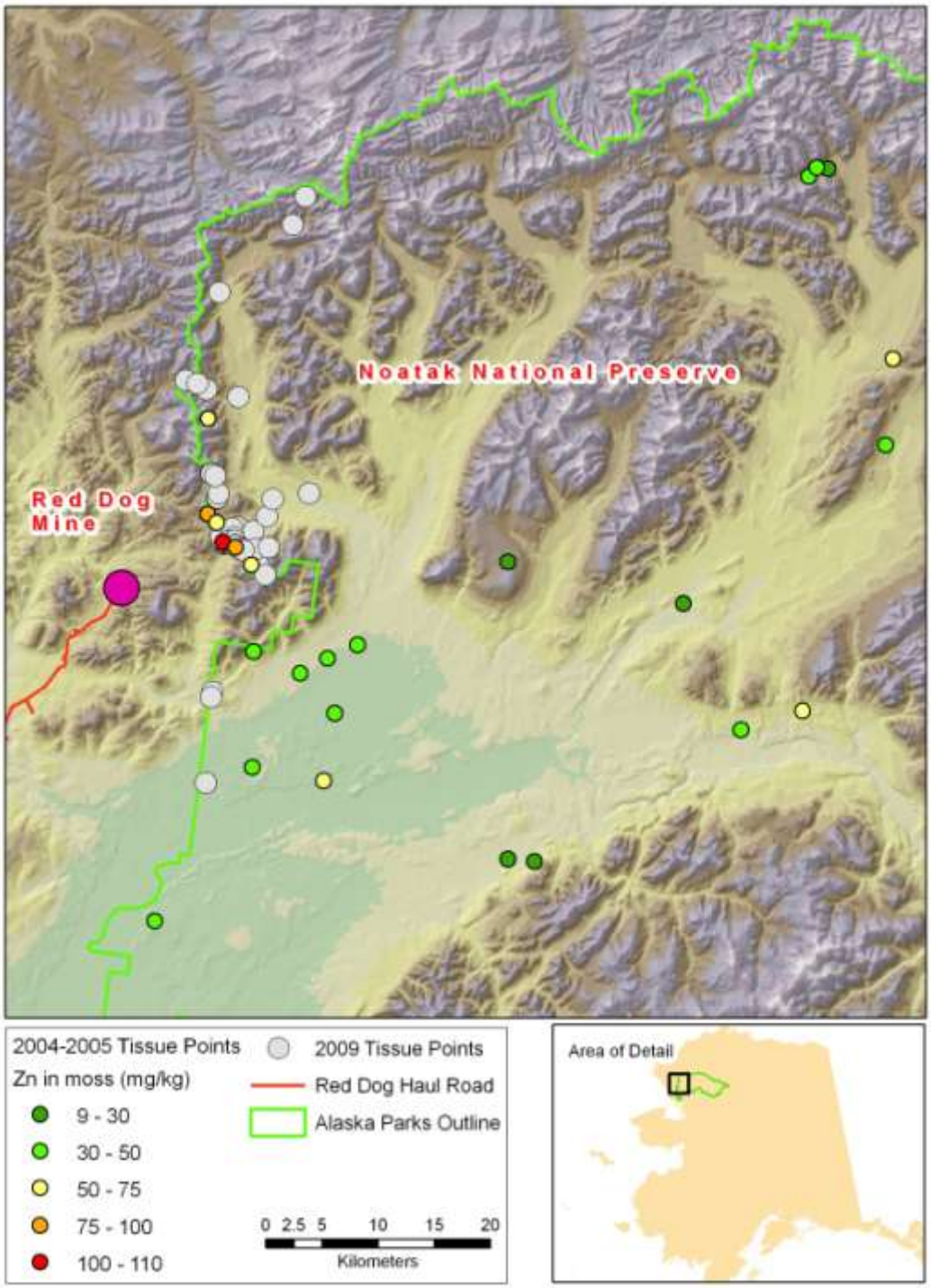

Figure 1. 2009 moss tissue sampling points in the potential contaminants zone from Red Dog Mine, Alaska. Also plotted are the 2004 and 2005 tissue sampling results for Zn. Points plotted in orange or red were at, or in excess of the 75 mg/kg Zn threshold proposed for lichen community effects along the Red Dog Haul Road in Neitlich et al. (2010).

References

Hasselbach, L., J.M. Ver Hoef, J. Ford, P. Neitlich, E. Crecelius, S. Berryman, B. Wolk, and T. Bohle. 2005. Spatial patterns of cadmium and lead deposition on and adjacent to National Park Service lands in the vicinity of Red Dog Mine, Alaska. Sci. Total Environ. 348:211–230.

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Neitlich, P., and J. VerHoef. 2011. Remeasurement of heavy metal deposition patterns in Cape Krusenstern National Monument, Alaska, adjacent to the Red Dog Mine Haul Road. *In prep.*